

WHAT IS CLAIMED IS:

1. A noise suppression apparatus, which can remove an inutile noise from an input signal comprising an object signal and the inutile noise mixed therein to output the object signal, said apparatus comprising:

a time/frequency conversion unit which converts the input signal into an amplitude spectrum and a phase spectrum by frequency-analyzing the input signal in each frame;

a noise-likeness analyzing unit which determines the noise-likeness of the input signal frame;

a noise amplitude spectrum calculation unit which calculates the noise amplitude spectrum from the input amplitude spectrum of the frame on the basis of the result of said noise-likeness analyzing unit;

a spectrum correction gain calculation unit which calculates a noise amplitude spectrum correction gain, on the basis of the input amplitude spectrum, the noise amplitude spectrum and a first predetermined coefficient, and which calculates a noise removal spectrum correction gain, on the basis of the input amplitude spectrum, the noise amplitude spectrum and a second predetermined coefficient;

a spectrum deduction unit which calculates a product of the noise amplitude spectrum and the noise amplitude spectrum correction gain, which is sent from said spectrum correction gain calculation unit, then deducts the product from the input

amplitude spectrum so as to output a first noise removal spectrum;

a spectrum suppression unit which calculates a product of the first noise removal spectrum and the noise removal spectrum correction gain so as to output a second noise removal spectrum; and

a frequency/time conversion unit which converting the second noise removal spectrum to a time domain signal.

2. The noise suppression apparatus according to claim 1 wherein said spectrum correction gain calculation unit comprises,

a spectrum correction gain limiting value calculation unit which calculates spectrum correction gain limiting values, on the basis of the input amplitude spectrum and the noise amplitude spectrum, which spectrum correction gain limiting values limit the correction gains of the noise amplitude spectrum and the noise removal/spectrum; and

a correction gain calculation unit which calculates a noise amplitude spectrum correction gain and a noise removal spectrum correction gain, on the basis of the input amplitude spectrum, the noise amplitude spectrum and the spectrum correction gain limiting value, which noise amplitude spectrum correction gain corrects the value of the amplitude of the noise amplitude spectrum in each frequency component, and which noise

removal spectrum correction gain corrects the value of the amplitude of the noise removal spectrum for each frequency component.

5 3. The noise suppression apparatus according to claim 2 further comprising a spectrum band dividing unit which divides the input amplitude spectrum sent from said time/frequency conversion unit into a plurality of frequency bands and calculates the average spectrum of each frequency band, and
10 divides the noise amplitude spectrum from said noise amplitude spectrum calculation unit into a plurality of frequency bands and calculates the average spectrum of each frequency band,

wherein said spectrum correction gain limiting value calculation unit and said correction gain calculation unit,
15 that form said spectrum correction gain calculation unit, calculate the spectrum amplitude limiting value, noise amplitude spectrum correction gain and the noise removal spectrum correction gain, on the basis of average spectrum of each frequency band of the input amplitude spectrum and the
20 noise amplitude spectrum, which are outputs of said spectrum band dividing unit, in place of the input amplitude spectrum and the noise amplitude spectrum.

4. The noise suppression apparatus according to claim 1 further comprising,

a spectrum smoothing coefficient calculation unit which calculates smoothing coefficients of the input amplitude spectrum and the noise amplitude spectrum, according to the state of the input signal; and

a spectrum smoothing unit which smoothes the input amplitude spectrum and the noise amplitude spectrum in the time base and in the frequency base, on the basis of the spectrum smoothing coefficients, and outputs a smoothed input amplitude spectrum and a smoothed noise amplitude spectrum,

wherein said spectrum correction gain calculation unit comprises a correction gain calculation unit which calculates a noise amplitude spectrum correction gain and a noise removal spectrum correction gain, on the basis of the smoothed input amplitude spectrum and the smoothed noise amplitude spectrum, which noise amplitude spectrum correction gain is used for correcting the value of the amplitude for each frequency component of the noise amplitude spectrum, and which noise removal spectrum correction gain is used for correcting the value of the amplitude of the noise removal spectrum.

5. The noise suppression apparatus according to claim 4 further comprising a spectrum band dividing unit which divides the input amplitude spectrum sent from said time/frequency

conversion unit into a plurality of frequency bands and calculates the average spectrum of each frequency band, and divides the noise amplitude spectrum sent from said noise amplitude spectrum calculation unit and calculates the average spectrum of each frequency band,

wherein said spectrum smoothing coefficient calculation unit calculates smoothing coefficients for the input amplitude spectrum and the noise amplitude spectrum, on the basis of the input amplitude average spectrum of each frequency band and the noise amplitude average spectrum of each frequency band, which are sent from said spectrum band dividing unit, and

wherein said spectrum smoothing unit calculates the smoothed input amplitude spectrum and the smoothed noise amplitude spectrum, on the basis of the input amplitude average spectrum of each frequency band and the noise amplitude average spectrum of each frequency band, which are sent from said spectrum band dividing unit.

6. The noise suppression apparatus according to claim 2 further comprising,

a spectrum smoothing coefficient calculation unit which calculates the smoothing coefficients for the input amplitude spectrum and the noise amplitude spectrum, according to the state of the input signal; and

a spectrum smoothing unit which smoothes the input

amplitude spectrum and the noise amplitude spectrum in the time base and in the frequency base, using the smoothing coefficients of the spectra,

wherein said correction gain calculation unit calculates
5 the noise amplitude spectrum correction gain and the noise removal spectrum correction gain, on the basis of the smoothed input amplitude spectrum, smoothed noise amplitude spectrum and the spectrum correction gain limiting value, in place of the input amplitude spectrum and the noise amplitude spectrum.

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7. The noise suppression apparatus according to claim 6 further comprising a spectrum band dividing unit which divides the input amplitude spectrum sent from said time/frequency conversion unit into a plurality of frequency bands and
15 calculates the average spectrum of each frequency band, and divides the noise amplitude spectrum sent from said noise amplitude spectrum calculation unit into a plurality of frequency bands and calculates the average spectrum of each frequency band,

20 wherein said spectrum smoothing coefficient calculation unit, said spectrum smoothing unit, said spectrum correction gain limiting value calculation unit and said correction gain calculation unit use the output from said spectrum band dividing unit in place of the input amplitude spectrum and the noise
25 amplitude spectrum, for carrying out their function.

8. The noise suppression apparatus according to claim 4
wherein said spectrum smoothing coefficient calculation unit
calculates the smoothing coefficients for the input amplitude
spectrum and the noise amplitude spectrum, according to the
5 result of the noise likeness analyzing unit.

9. The noise suppression apparatus according to claim 6
wherein said spectrum smoothing coefficient calculation unit
calculates the smoothing coefficients for the input amplitude
10 spectrum and the noise amplitude spectrum, according to the
result of the noise likeness analyzing unit.

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